Description

PRODUCTION OF A COMPLETE IMAGE BY SCANNING PARTIAL AREAS OF A PATTERN

The invention relates to a method according to the preamble of Claim 1.

Such a method can, for example, be used to obtain a panoramic image or also to scan documents.

The solid angle given by a camera and objective which is scanned or recorded by an image is in many situations inadequate for completely recording objects from the surroundings. The use of in particular wide-angle objectives to completely record objects is not always possible or always desired. Because of the characteristics of the lens, a very wide-angle objective causes extreme distortions at the edges of the image which interfere considerably with the impression. Furthermore, the quality of the object display is disturbed by the limited sensor resolution. In many cases, however, replacement of the lens or of the objective is not possible either, because this component is firmly integrated into the camera.

Many methods have already been used which have dealt with a similar subject. The focus of the observation here was frequently on the generation of panoramic images. To correct the sensor defect, however, the known methods for generating images of a larger field of vision require very expensive and complex arithmetical operations that cannot be performed in real video time to correct the lens and image distortion. For this reason, a calculation of an image with an extended field of vision can only be performed offline as a rule.

The images used to generate the result image only require a slight overlap in this method. In this case, two adjacent images or two consecutive images contain only a little common image information. Depending on the environment, however, the images therefore integrally contain quite different lighting conditions. An aperture control on the camera, however, results in extremely varied illuminations at the spliced edges of the image which can likewise only be harmonized again at very great cost.

Fax equipment and flatbed scanners enable the electronic transmission of documents which are available on paper. In many situations the availability of this equipment, for example during a meeting, is not always guaranteed. An alternative to the use of a fax machine or a flatbed scanner is a digital camera, with which the image information can also be saved in digital form. However, the resolution of standard commercial cameras is not yet sufficient to produce adequate resolution for a document in a single exposure.

The scanning of documents by means of many individual images close up to the document to increase the resolution is a known approach. Until now there have only been a few, in part very unstable methods that can be used to compose a two-dimensional complete image from the individual recorded images again.

Most methods are based on the image information at first being distorted at an initial processing stage by highly complex arithmetical operations. At a subsequent processing stage, the adjacent image information is then harmonized with the adjacent images in all four edge directions. The images only require a slight overlap for this. Each image is corrected both horizontally

and vertically in relation to the adjacent images. Besides the scarcely tolerable high calculation time, these methods frequently lead to rhombic distortion of the image information which distracts the observer greatly (cf. Figure 1). On account of their complexity, the methods can frequently only be performed interactively and offline.

The object of the invention is to indicate a method of the type mentioned at the beginning which provides a high-quality result image without a great amount of calculation.

This object is achieved according to the invention by the features indicated in Claim 1.

The method according to the invention has the following advantages:

- Rapid processing
- Correction of the lens errors or mapping errors in the image involving intensive calculations is not necessary
- Harmonization of illumination at the spliced edges is rendered unnecessary by virtually continuous image scanning
- Control of the additional image information as a function of the image misalignment.

The invention is described in more detail hereinafter with reference to an exemplary embodiment shown in the diagram. The diagram shows:

Figure 1 a complete image prepared from individual exposures according to the prior art,

Figure 2 a result image generated by scanning the surroundings,

Figure 3 a scanning movement for scanning a document,

Figure 4 the image recorded during the scanning movement according to Figure 2,

Figure 5 the result of successive one-dimensional scans, and

Figure 6 the result image according to the method according to the invention.

The method according to the invention is based on the production of individual images which are generated during a one- or two-dimensional scanning movement.

According to the invention individual images are generated which overlap each other to a high degree. This produces a complete image with almost no distortions which covers a very large solid angle. The method makes it possible, for example, to produce panoramic images or also to scan in documents with a very high resolution.

In doing so, the image sensor operates, for example, at full scanning frequency so that by slowly swiveling across the object to be recorded, adjacent images are only slightly offset against each other. From each image a part of the undistorted image information is copied from the center of the image into a result image. The size of the copied picture detail is controlled as a function of the calculated offset to the previous image. As two adjacent images overlap to a very high degree, the images have almost identical lighting conditions so that when adjacent edges are put together, as a rule no harmonization of the illumination is necessary.

To perform the method according to the invention, for example, a mobile telephone with the following components is used:

- Camera module on the reverse of the mobile telephone for recording images from the surroundings
- Processor for processing the image data and for generating the result image (estimate of movement, image composition, etc.)
- Display for image display

The function to generate the result image (cf. also Figure 2) on the basis of an image sequence essentially comprises the following processing stages:

- Estimate of movement of two adjacent images
- Structure of the result image

In the following sections the individual processing stages of the methods are explained in more detail with the simplification that the scan follows the surroundings one-dimensionally from right to left:

1) Estimate of movement of two adjacent images

The movement of two adjacent images is determined, for example, according to the MSE (Mean Squared Error) method. In this method, the best possible match in a local neighborhood to the previous image is sought for an image area of the initial image. The best match provides the displacement vector of the two images relative to each other.

2) Updating the result image

On the basis of the displacement vector, the position inside the result image to which the additional image information is copied is ascertained. The width of the additional picture detail of the initial image is provided by the offset of the images in the direction of scanning (direction x). In this way no gap arises between the picture detail already put together and the added picture detail. Vertical to the direction of scanning (direction y) the complete image information is taken into account. The result of the processing of many images according to this method can be seen in Figure 1.

In a development of the method according to the invention, scanning of the document takes place by means of a zigzag movement of the

camera across the document at a constant distance (cf. Figure 3). In order to avoid variations in the distance to the document and consequently changes in the size of the images during the scanning process, for example, the camera is guided across the document on a frame with the camera pointing vertically downwards. By analyzing the movement of consecutive images, the two-dimensional scan is separated into several one-dimensional (horizontal) scans (cf. Figures 4 and 5). Each one-dimensional scan shows a horizontal, undistorted strip of the original document. By separating the two-dimensional scan into several one-dimensional scans, the problem of document generation is reduced to horizontal scaling of the image strips and the putting together of the horizontal strips in a vertical direction (cf. Figure 5). Linear scaling of all the image information avoids rhombic distortions in the complete image, as occurs in traditional methods (cf. Figure 6).